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Wu et al.

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(45) **Date of Patent:** Jul. 10, 2007

(54) **METHODS FOR PRODUCING LOW STRESS POROUS LOW-K DIELECTRIC MATERIALS USING PRECURSORS WITH ORGANIC FUNCTIONAL GROUPS**

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(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 113 days.

U.S. Office Action mailed May 31, 2006, from U.S. Appl. No. 10/941,502.

(Continued)

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Primary Examiner—M. Wilczewski

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(74) *Attorney, Agent, or Firm*—Beyer Weaver LLP

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H01L 21/31 (2006.01)
H01L 21/469 (2006.01)
C23C 16/40 (2006.01)
C23C 16/56 (2006.01)

(52) **U.S. Cl.** 438/781; 438/789; 438/790;
427/557

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427/551, 553, 557; 438/507, 509, 780-782,
438/787, 788, 789, 790, 783, 784
See application file for complete search history.

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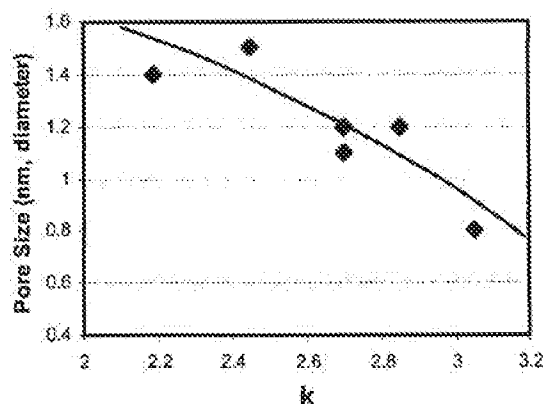
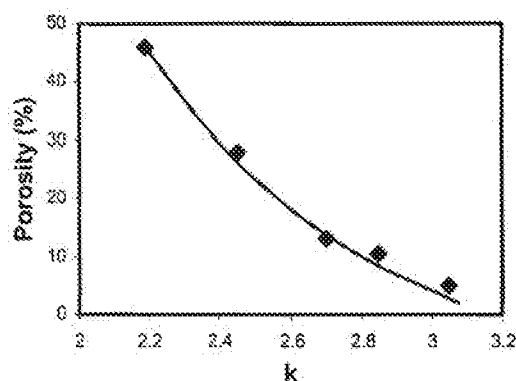
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(57) ABSTRACT

Methods of preparing a low stress porous low-k dielectric material on a substrate are provided. The methods involve the use of a structure former precursor and/or porogen precursor with one or more organic functional groups. In some cases, the structure former precursor has carbon-carbon double or triple bonds. In other cases, one or both of the structure former precursor and porogen precursor has one or more bulky organic groups. In other cases, the structure former precursor has carbon-carbon double or triple bonds and one or both of the structure former precursor and porogen precursor has one or more bulky organic groups. Once the precursor film is formed, the porogen is removed, leaving a porous low-k dielectric matrix with high mechanical strength. Different types of structure former precursors and porogen precursors are described. The resulting low stress low-k porous film may be used as a low-k dielectric film in integrated circuit manufacturing applications.

30 Claims, 7 Drawing Sheets





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(19) United States

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(54) POROUS INSULATING FILM, METHOD FOR PRODUCING THE SAME, AND SEMICONDUCTOR DEVICE USING THE SAME

(30) Foreign Application Priority Data

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Publication Classification

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(52) U.S. Cl. 438/790

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(57) ABSTRACT

(21) Appl. No.: 10/580,606

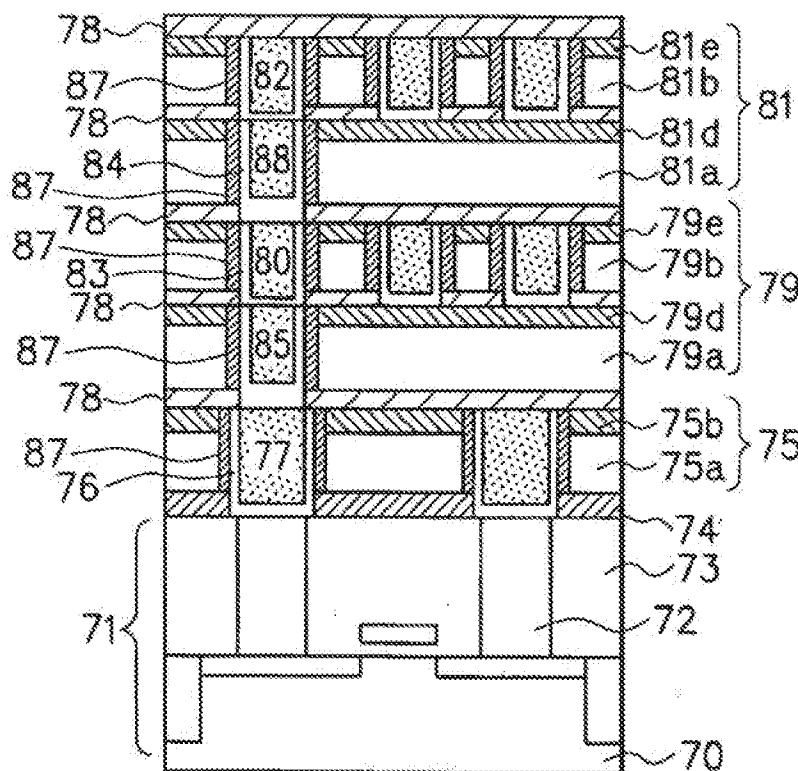
(22) PCT Filed: Nov. 29, 2004

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§ 371(c)(1),

(2), (4) Date: May 25, 2006

The present invention provides a process of producing a porous insulating film effective as an insulating film constituting a semiconductor device and a process of producing a porous insulating film having high adhesion to a semiconductor material, which is in contact with the upper and lower interfaces of the insulating film. Gas containing molecule vapor of at least one or more organic silica compounds, which have a cyclic silica skeleton in its molecule and have at least one or more unsaturated hydrocarbon groups bound with the cyclic silica skeleton is introduced into plasma to grow a porous insulating film on a semiconductor substrate.





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10/703,082

METHOD FOR FORMING INSULATION FILM AND APPARATUS FOR FORMING INSULATION FILM

Select New Case	Application Data	Transaction History	Image File Wrapper	Patent Term Adjustments	Foreign Priority	Fees	Published Documents	Address & Attorney Agent
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06-18-2009	NOA	Notice of Allowance and Fees Due (PTOL-85)	4	<input type="checkbox"/>		
06-18-2009	FWCLM	Index of Claims	1	<input type="checkbox"/>		
06-18-2009	SRFW	Search information including classification, databases and other search related notes	1	<input type="checkbox"/>		
06-18-2009	IFWV	Issue Information including classification, examiner, name, claim, renumbering, etc.	1	<input type="checkbox"/>		
05-18-2009	A...	Amendment/Req. Reconsideration After Non-Final Rejection	1	<input type="checkbox"/>		
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05-18-2009	REM	Amendment/Remarks Made in an Amendment	6	<input type="checkbox"/>		
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12-17-2008	FOR	Foreign Reference	77	<input type="checkbox"/>
12-05-2008	RCEX	Request for Continued Examination (RCE)	1	<input type="checkbox"/>
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12-05-2008	AMSB	Amendment Submitted/Entered with Filing of CPA/RCE	1	<input type="checkbox"/>
12-05-2008	CLM	Claims	3	<input type="checkbox"/>
12-05-2008	REM	Applicant Arguments/Remarks Made in an Amendment	5	<input type="checkbox"/>
12-05-2008	WFEE	Fee Worksheet (FIG-875)	2	<input type="checkbox"/>
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12-05-2007	SRFW	Search information including classification, databases and other search related notes	1	<input type="checkbox"/>
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07-01-2004	FOR	Foreign Reference	11	<input type="checkbox"/>
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06-28-2004	CLM	Claims	2	<input type="checkbox"/>
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06-28-2004	OATH	Oath or Declaration Filed	2	<input type="checkbox"/>
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